Time Series Analysis of Cedar Bayou

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Mukesh Subedee

- 2nd year Masters' Student, GIS for Development and Environment (GISDE), Clark University
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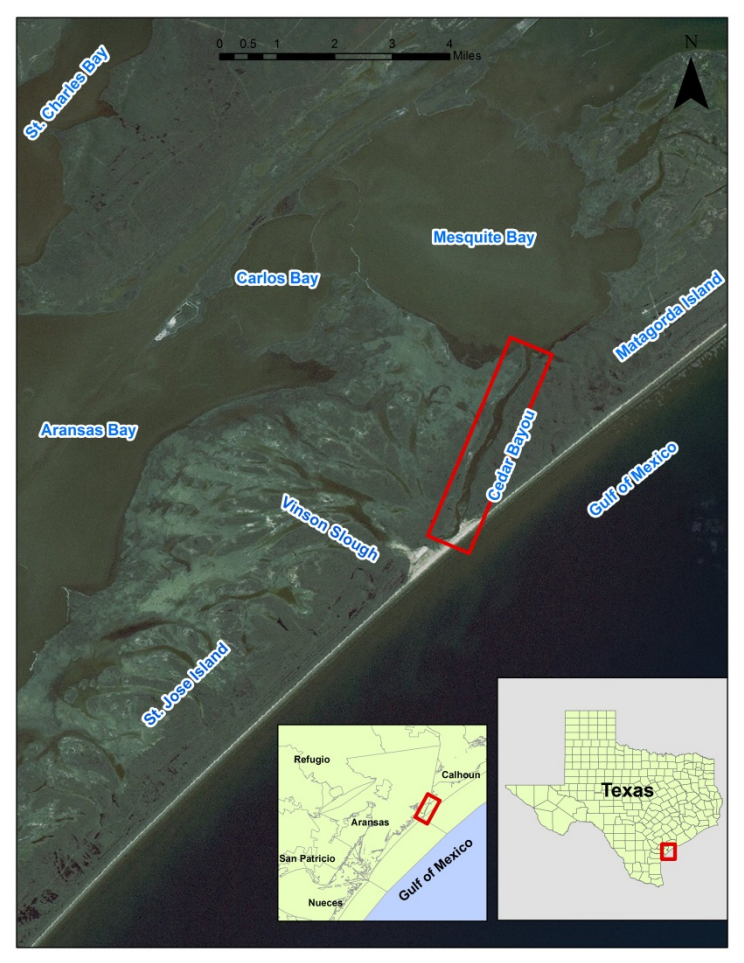
- Research Interest:
  - GIS and spatial analysis
  - Remote Sensing
  - Web mapping

Dr. James Gibeaut

- Endowed Chair for Geospatial Sciences, Harte Research Institute for Gulf of Mexico Studies (HRI), Texas A&M University-Corpus Christi
- Director, Coastal & Marine Geospatial Lab, HRI
- Associate Professor of Geology, Texas A&M University-Corpus Christi
- Expertise:
    - Coastal Morphodynamics
    - GIS
    - Modeling Effects of Sea level Rise

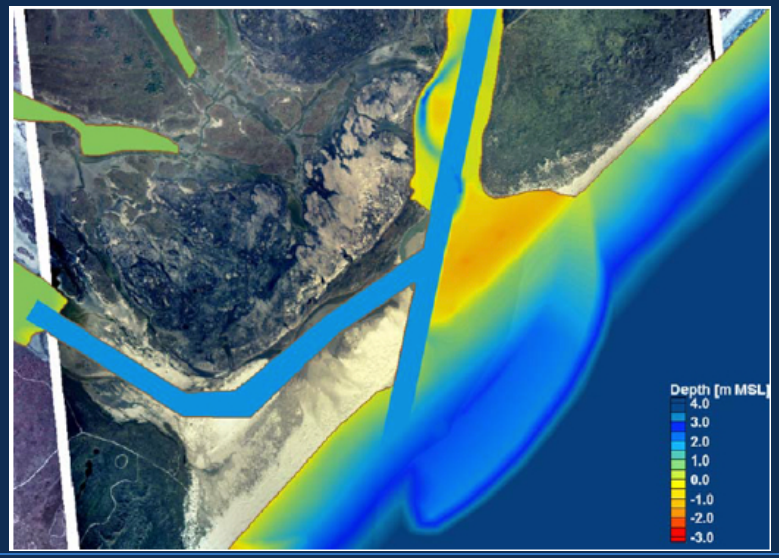
Project Overview



- Cedar Bayou – a natural unstable pass that connects the Gulf of Mexico and Mesquite Bay
- Passage for migratory organisms
- Connection to Vinson Slough
- Back-island is relatively stable but beach zone is remarkably changed
- Status: open and closed regularly

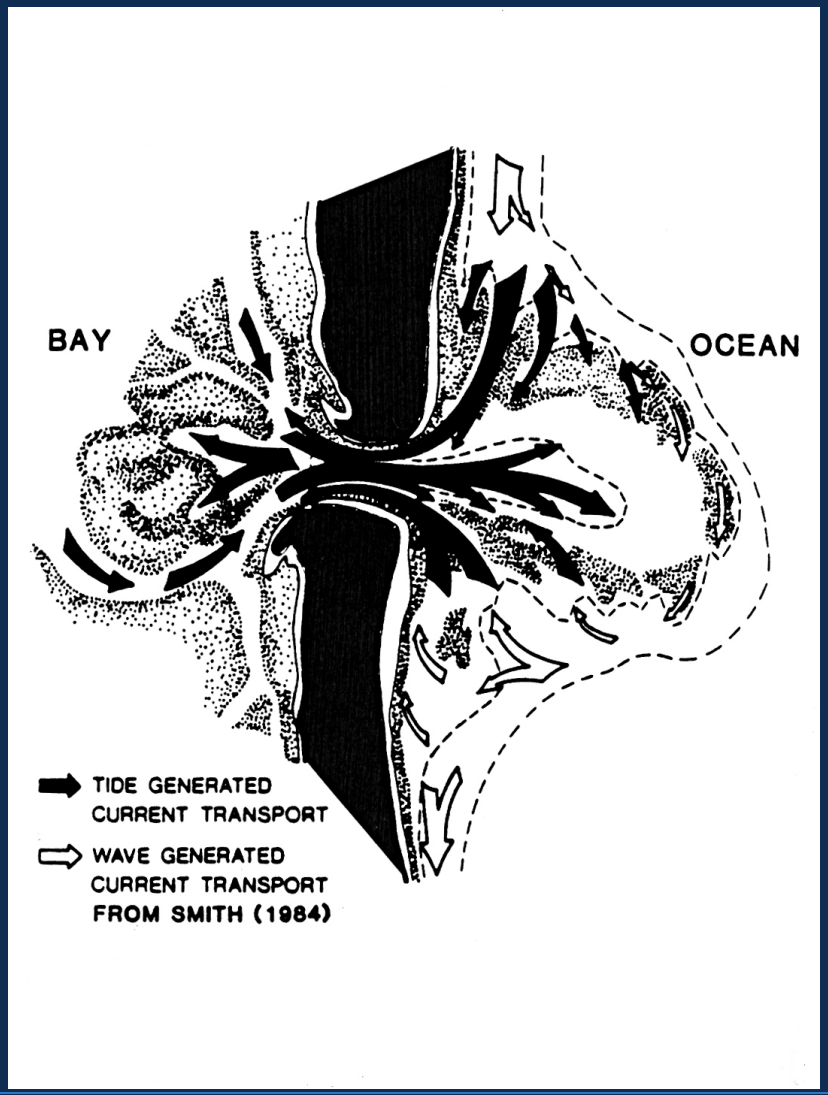
Research Objective

- Coast and Harbor Engineering (2005) approach:
  - Dredge a straight Cedar Bayou connection to the Gulf, connection to Vinson Slough, and reconstruction of the submerged ebb shoal with dredged material



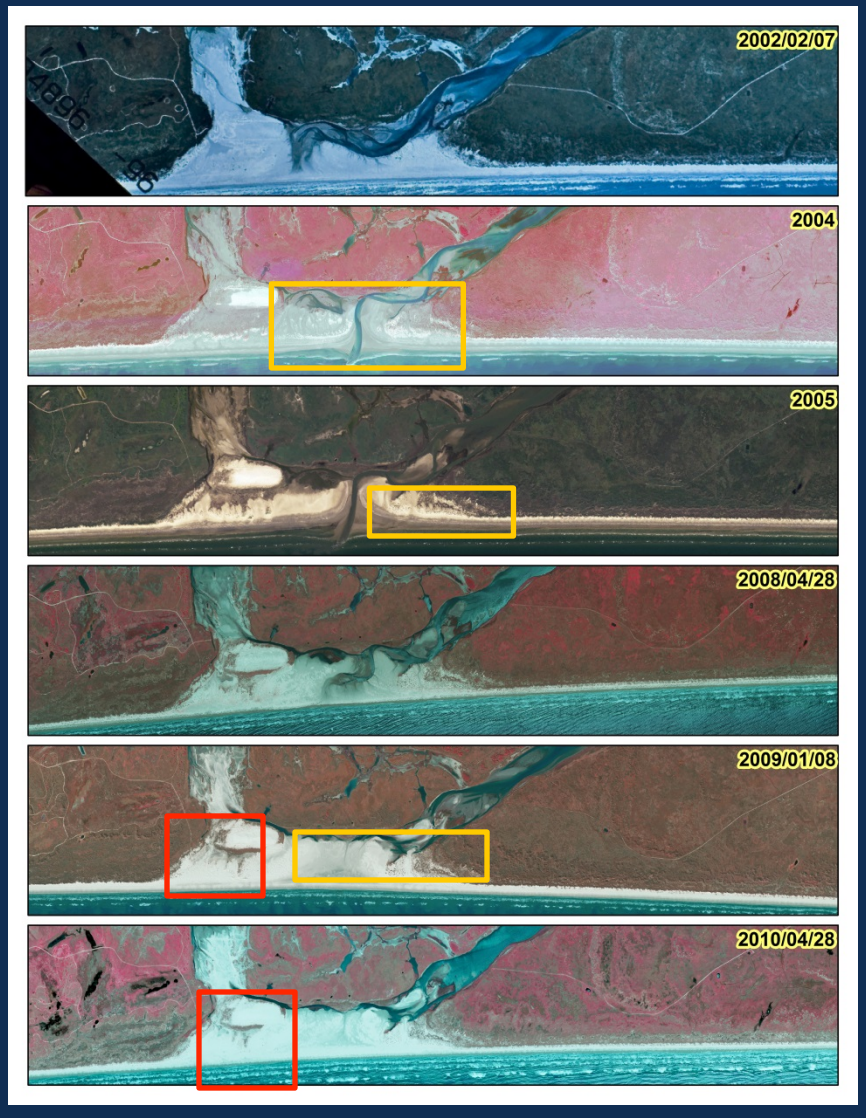
- Will Cedar Bayou stay open?
  - Based on morphologic responses of the pass to past processes
  - What happened in the past?
- Data Used:
  - Aerial Imagery (1860-2010)
  - River discharge data (1939-2013)
  - Tropical Storm and Hurricane data (1851-2013)
  - Tide data (1963-2013)
  - Wave Hindcast data (1956-1999)
  - LiDAR and Historical Shoreline (1860-2012)

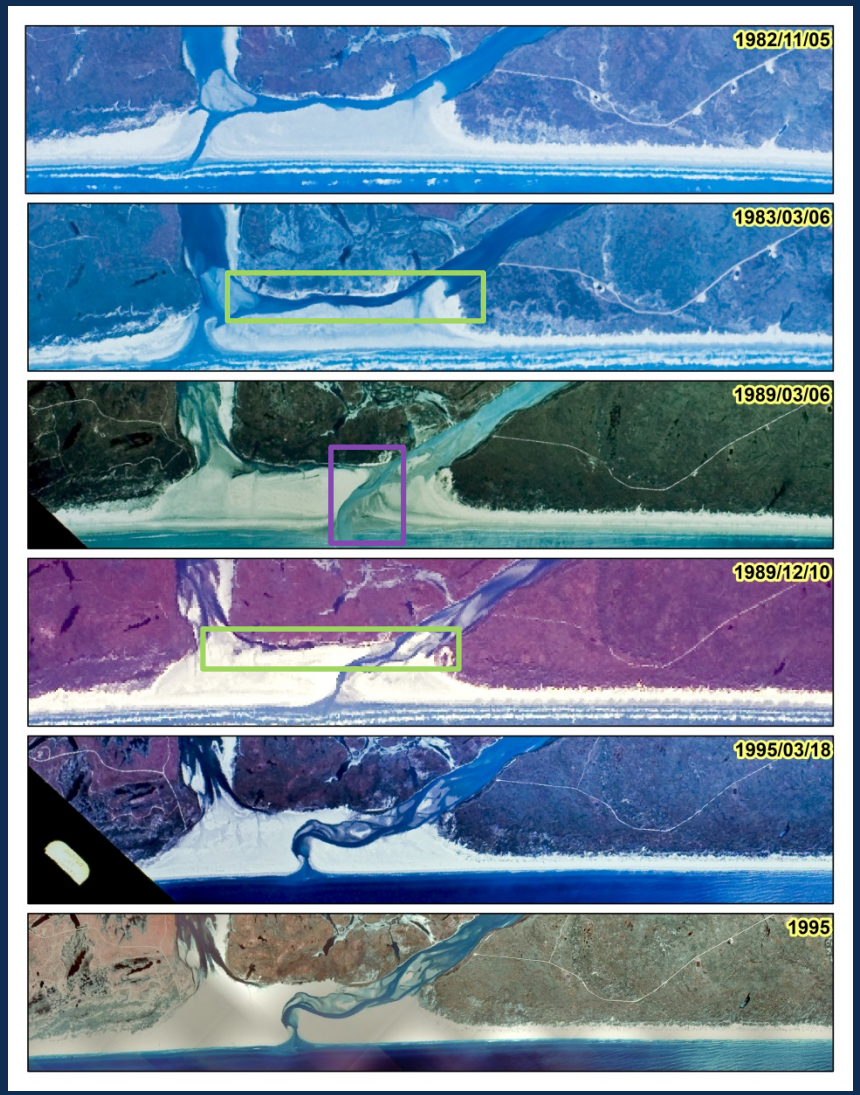
Tide and Wave Energy



- Morphology is constantly modified with the complex temporal and spatial interactions of waves, tides, and longshore currents
- Tide dominated system
- Wave dominated system

Aerial Imagery

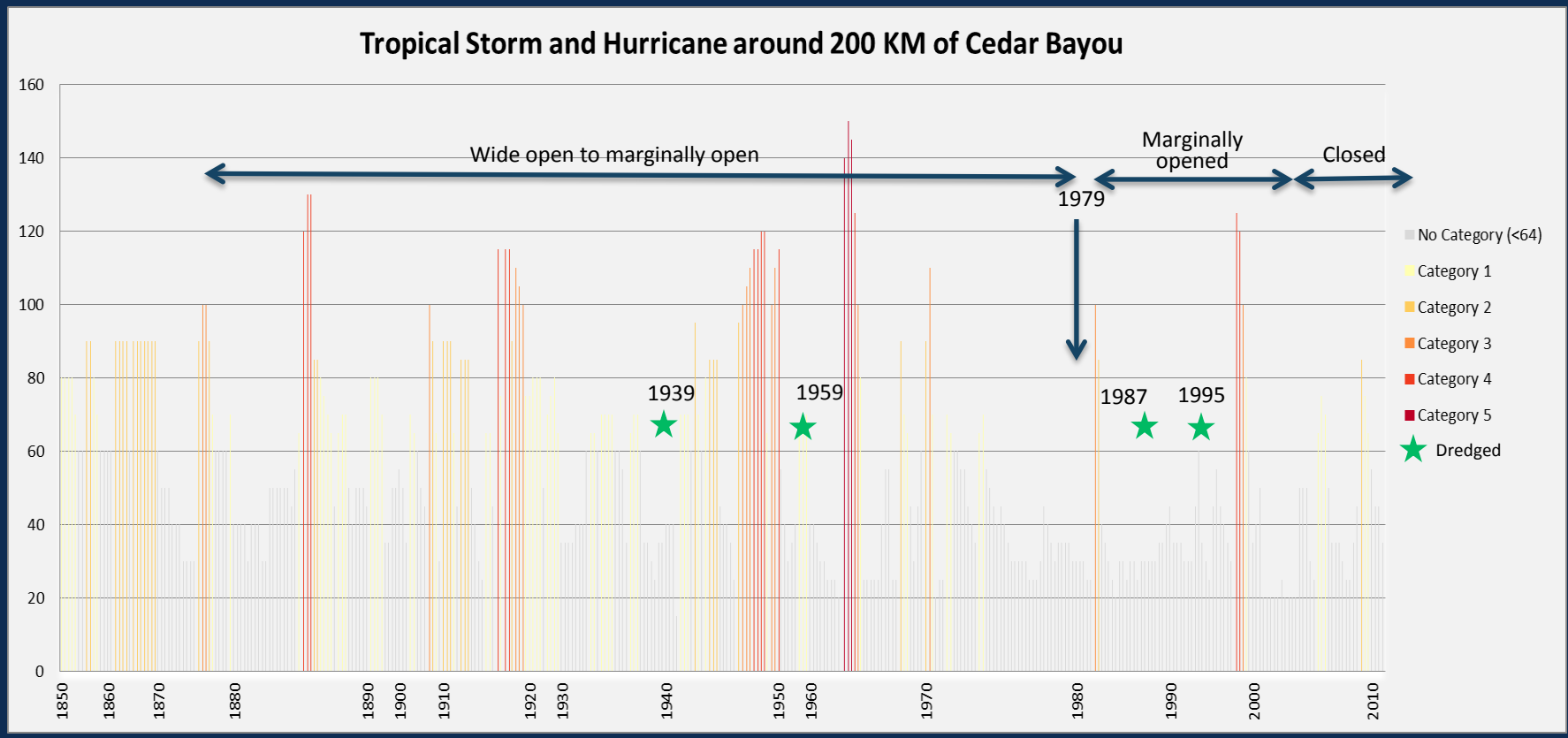




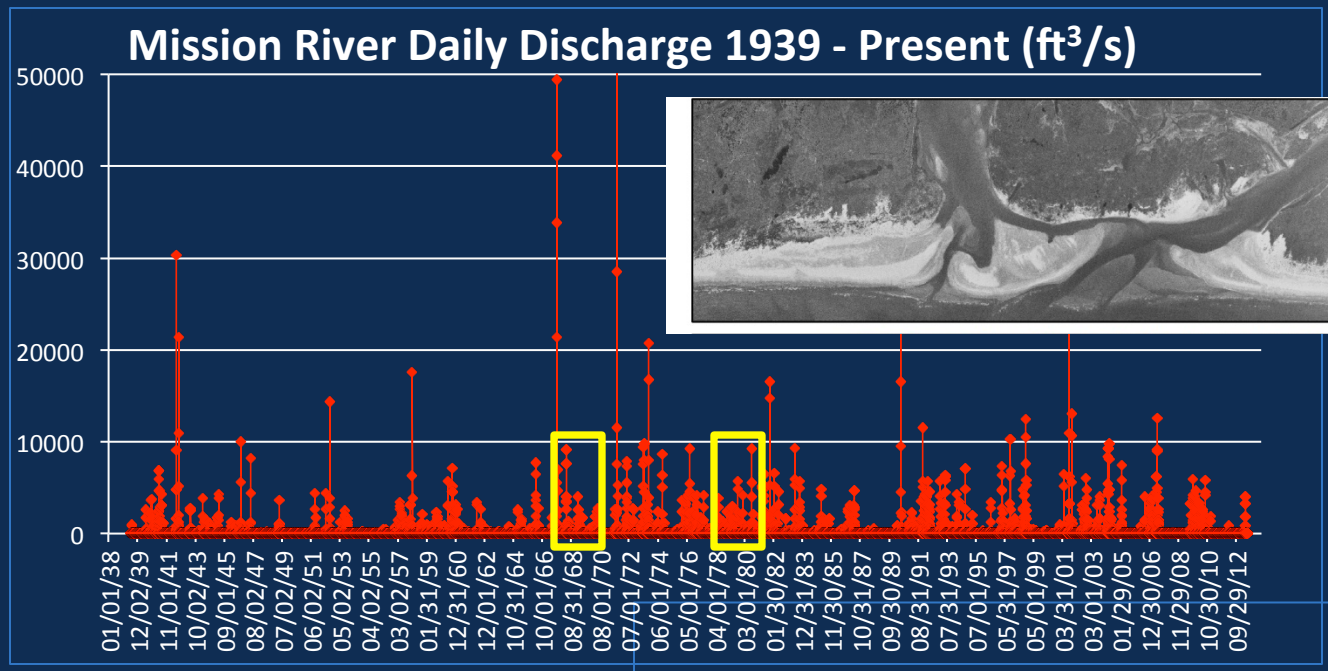
Throat Width Calculation

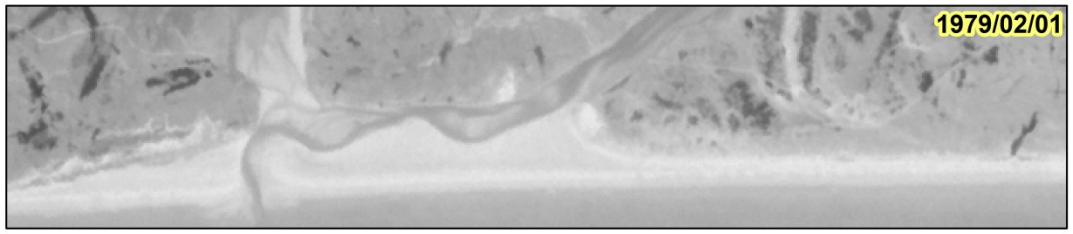
Date	Throat Width (meter)	Observation
1870	480	Significant connection between CB and VS, single channel to the Gulf
4/22/1969	415	Separate channels from both CB and VS; CB and VS connected
9/1/1972	425	Channel move westward with CB and VS merged as a single channel to the Gulf
2/1/1979	70	Small channel between CB and VS, channel has further shifted towards VS
11/11/1979	CLOSED	Closed by sand berm to prevent pollution from Ixtoc I oil spill (June 1979)
2/12/1981	58	No more sand berm, very small opening to the Gulf; small connection between CB and VS
11/5/1982	45	CB and VS still connected but even smaller channel from VS than 1981, the island on the mouth of VS has increased and the pass has moved slightly westward than 1981
3/6/1983	65	Increasing seashore mouth width, slightly wider channel to the Gulf than 1982
3/6/1989	60	Dredged in June 1988 that shifted the pass toward CB and completely closed along VS, very small connection between CB and VS
12/10/1989	32	Throat width reduces even more with barely connection between CB and VS
3/18/1995	40	Almost no connection between CB and VS
2/7/2002	CLOSED	Closed, although 300,000 cu yards dredged in 1995 and hurricane in 1999
2004	40	Narrow channel and low water level, hurricane Claudette in 2003 could have opened the channel
2005	90	Could be the result of hurricane Emily in 2005 as it looks like high tide event
4/28/2008	CLOSED	Drainage channel can be seen
1/8/2009	CLOSED	No channel at all
4/28/2010	CLOSED	No channel

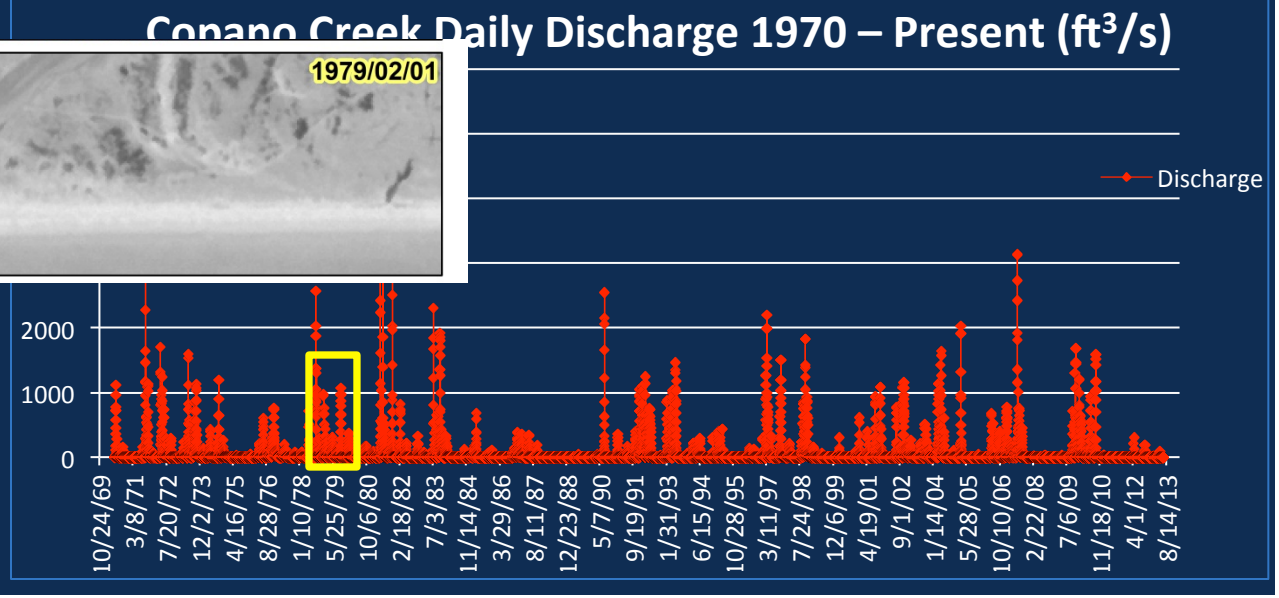
Tropical Storm and Hurricane



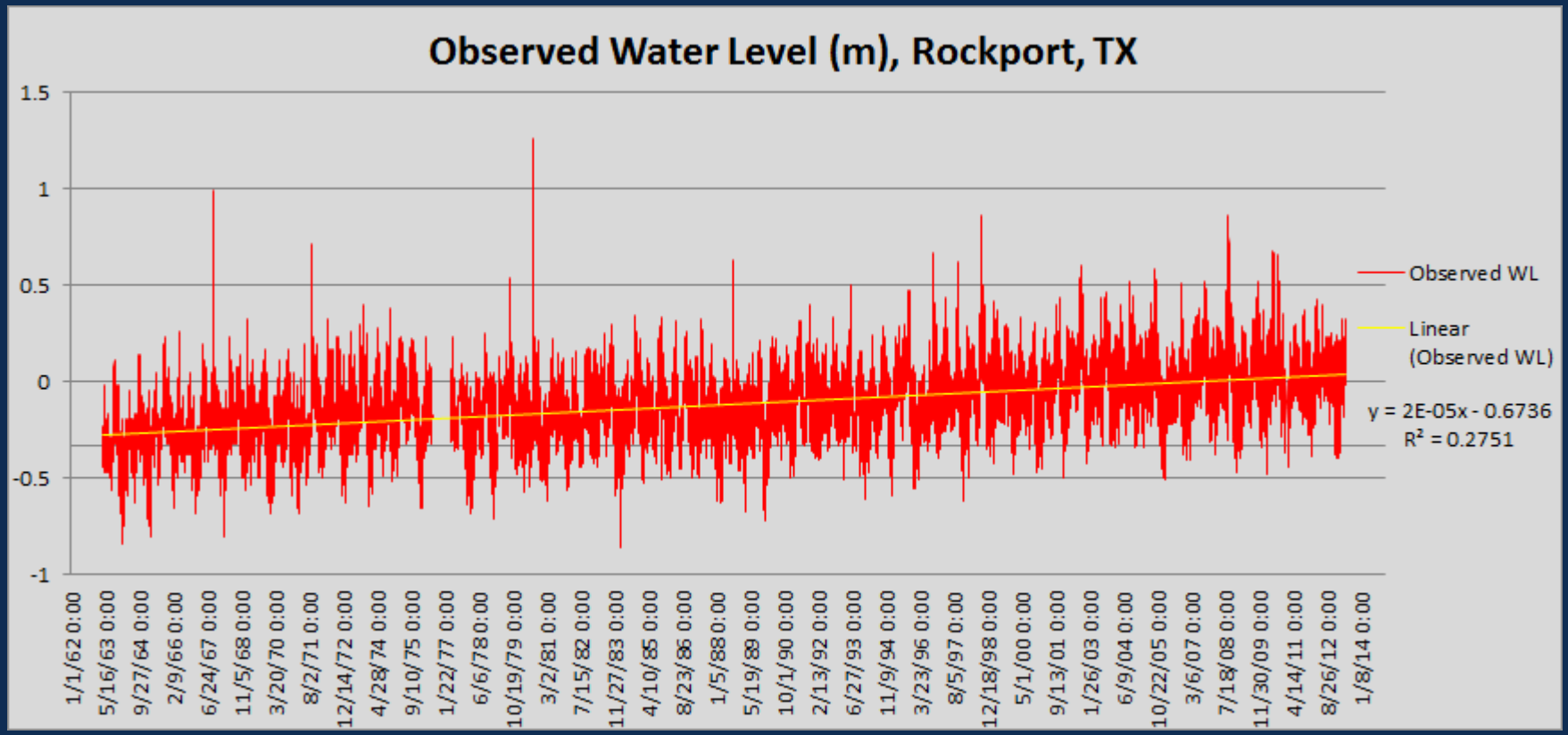
Surface Water Discharge







Tide Effect

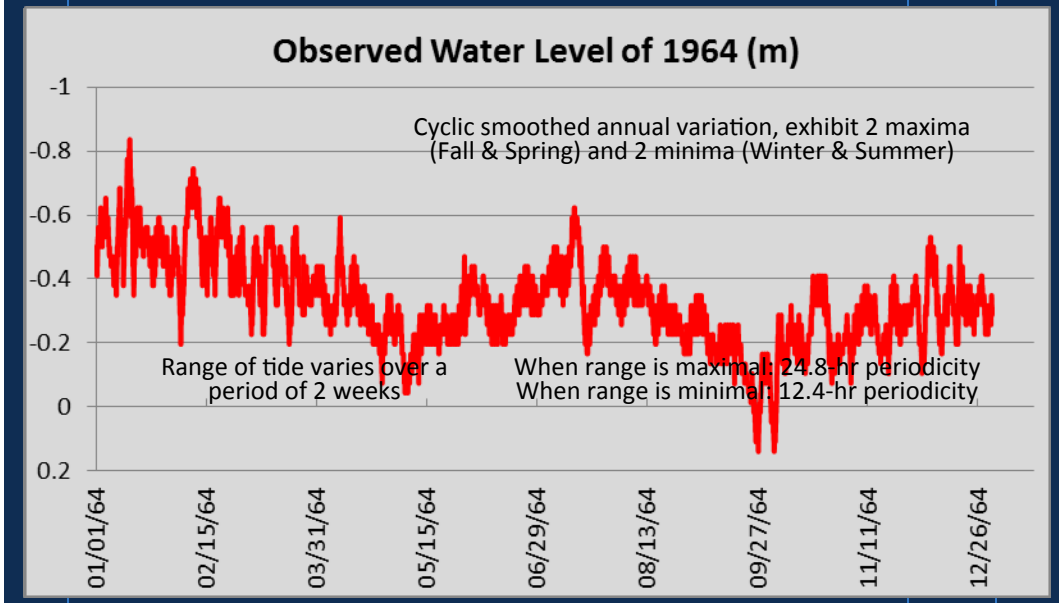


- Hourly observed water level:
  - Maximum: 1.258 m
  - Minimum: -0.855 m

Datum: MSL

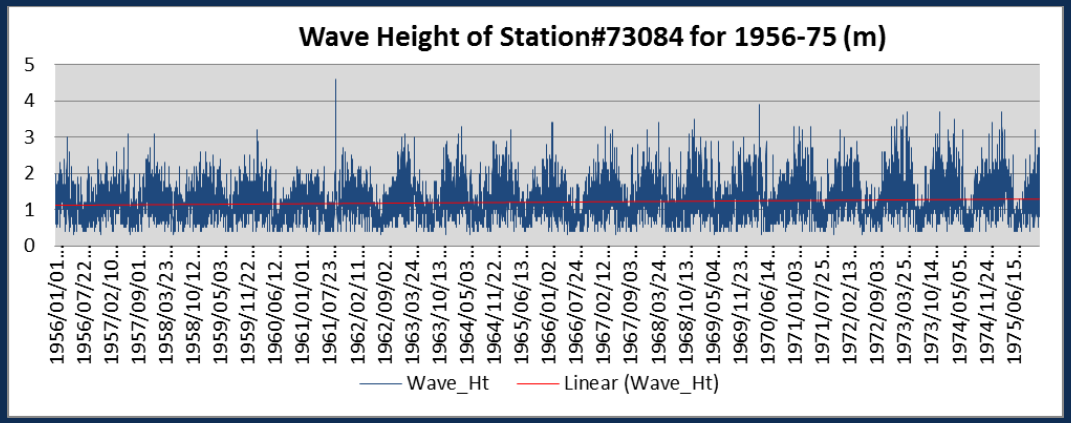
Tide Effect

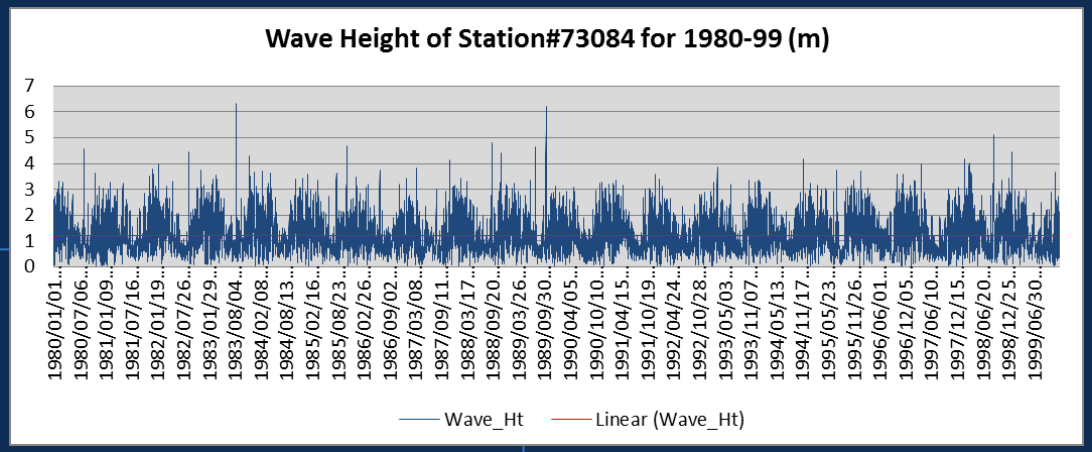
- Gulf of Mexico seafront tide is described by 12.4-hr semidiurnal and 28.4-hr diurnal tide, and 13.6 day fortnightly cycle and semi-annual mode of tide.



- The tide in the Gulf loses most of its energy as it passes through the inlets.
- Stilling well effect: inlet acts as a small port that connects a large oscillating chamber of water to smaller chamber in co-oscillation.

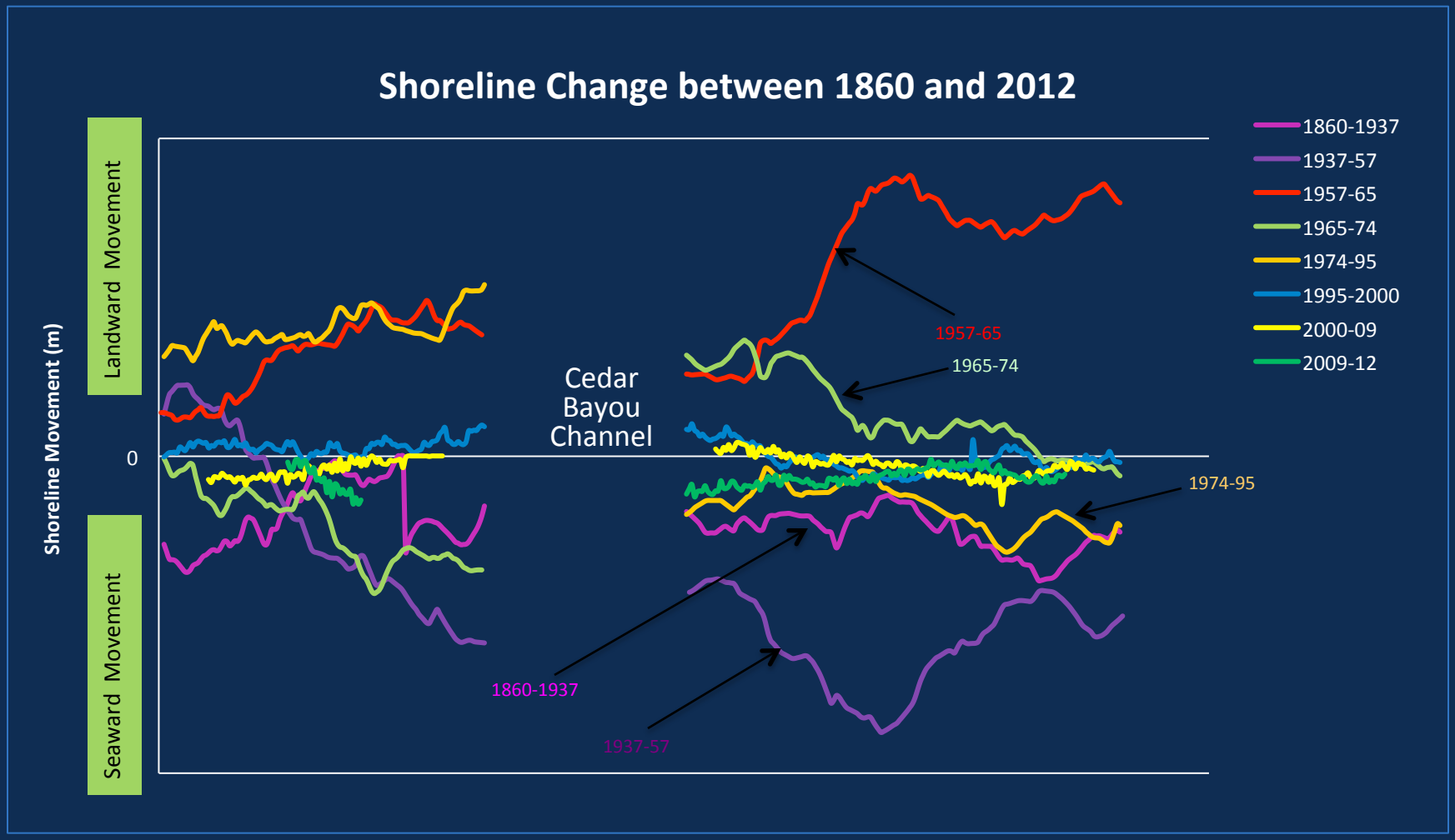
Wave Hindcast





- Average wave height:
  - 1956-1975: 1.215 m
  - 1980-1999: 1.192 m
- No significant difference in wave height over time

Shoreline Change

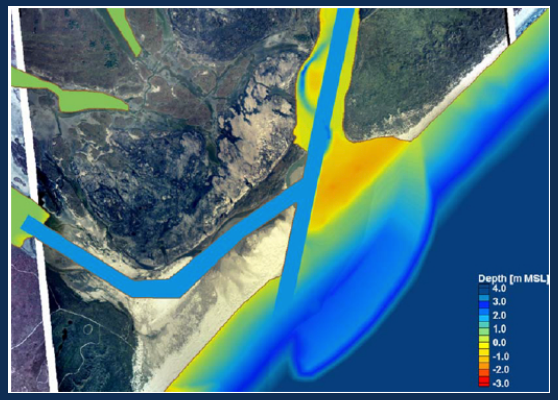


Conclusion

- For Cedar Bayou to remain open:
  - Need of sufficient channel flow to remove sediments deposited in the channel by longshore drift
- From our observations,
  - The “stilling well” effect reduces tidal energy when passing through the channel
  - The fresh water discharge into the bay is not able to maintain the opening
  - The occurrence of large hurricanes and dredging activities have historically played a major role in the opening/closing of Cedar Bayou
  - However, variations in non-storm tide and wave energy are not strongly related to the opening/closing of Cedar Bayou

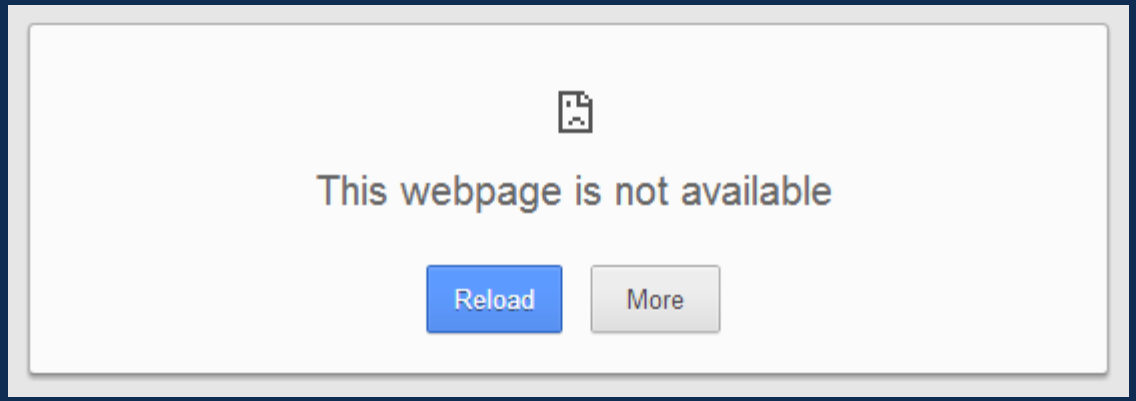
Conclusion

- Concerns regarding the project plan:
  - Vinson Slough is only dredged to connect Cedar Bayou channel which would only connect Aransas Bay during high tide
  - The claim that the ebb delta was present cannot be verified
  - Need of jetties and continuous maintenance dredging
  - Environmental impacts



Use of Metadata

- It helps to find data, and also helps to answer many questions about the dataset.
- Created metadata – in progress
- NCDDC MERMAid: Slow, slow, slow!!



Skills Learned and Challenges

Skills Learned

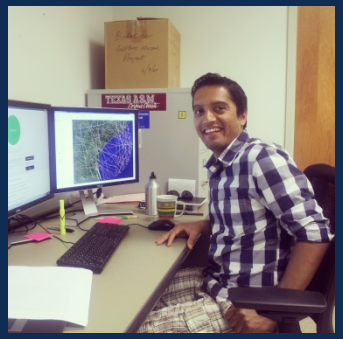
- Data acquisition
- LiDAR data usage on Shoreline Extraction
- Terrestrial laser scanning
- Real Time Kinematic (RTK) data collection

Challenges

- Lack of Metadata
- Overwhelming amount of data

Looking Back: Value of the Internship

- An exceptional opportunity
  - Understanding barrier Island formation to other process information
  - Field observations and data collection methods
  - Diverse research group



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Thank You!